Research work (Master)

Title: Design and development of detectors for tracking of elliptical objects in 2D/3D biological video sequences

Contacts: I. Arganda[1, 2]
F. Dornaika[1, 2]
ignacio.arganda@ehu.eus

[1] *Department of Computer Science and Artificial Intelligence, UPV/EHU.*
[2] *IKERBASQUE, Basque Foundation for Science.*

Over the past decades, the biological sciences have enjoyed tremendous advances in imaging techniques that provided new insights into dynamic phenomena. The development of analysis software to extract quantitative data on the dynamics of the processes examined by microscopy has been equally important. In particular, single-particle tracking software – computational tools that can follow objects in a time-lapse movie and quantify their dynamics – are crucial for almost any experiments involving live-cell imaging, and are a critical part of the researcher toolbox.

A number of programs have been designed and have undergone significant refinement over the past several years for single particle tracking of live cell microscopy images. There does not exist at this time a "one-size-fits-all", universally accurate tracking method. Many specific dynamic biological processes require their own specialized tracking tools that can derive and exploit unique aspects of process such as the motion or shape of the tracked objects. *TrackMate* [1] is an open and extensible platform for single-particle tracking distributed within the popular image processing toolbox *Fiji/ImageJ*. It is openly available and well documented, and it houses several detection and tracking modules that allow combining manual and automated particle tracking approaches. However, the default object detectors are optimized for blob-like objects and frequently fail to properly detect ellipse-shaped objects such as bacteria or mitochondria.

In this work, we aim at designing and developing novel solutions for the detection of elliptical objects in 2D/3D video sequences. In particular, we propose two different strategies that we wish to evaluate. Namely, morphological operators [2] and a supervised learning approach with pre-computed image features. The main tasks are as follows:

1. Studying the problem of elliptical object detection for tracking
2. Implementing the proposed solutions in *TrackMate*
3. Performing an evaluation of the detection strategies on real biological data

Required knowledge:
Java programming, image processing (basics), pattern recognition (basics)

References
[1] Jean-Yves Tinevez, Nick Perry, Johannes Schindelin, Genevieve M. Hoopes, Gregory D. Reynolds, Emmanuel Laplantine, Sebastian Y. Bednarek, Spencer L. Shorte, Kevin W. Eliceiri, TrackMate: An open and extensible platform for single-particle tracking, Methods, Available online 3 October 2016, ISSN 1046-2023.
[2] David Legland, Ignacio Arganda-Carreras, and Philippe Andrey. MorphoLibJ: integrated library and plugins for mathematical morphology with ImageJ. Bioinformatics, btw413, 2016.